

Performance Report on Surface Streets in the Seattle Central Business District

Volume 3: Second Update – Post Tunnel Closure



As required by the Agreement between King County, City of Seattle and Sound Transit, as revised June 24, 2002, for the Downtown Seattle Transit Tunnel and Related Facilities.

Prepared by the Monitor and Maintain Committee, with representation from the following agencies:



City of Seattle



King County



SOUNDTRANSIT



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Report Purpose

Volume 3 of this report, and subsequent updates, is intended to provide the documentation necessary to satisfy the requirements of Section 10.3 of the “Agreement Regarding the Design, Construction and Operation of the Downtown Seattle Transit Tunnel and Related Facilities”, as executed by the City of Seattle, King County and Sound Transit.

Excerpts from Section 10.3 of this Agreement read as follows:

“It is the Parties’ intent that the Downtown Seattle Traffic and Street Improvements will be sufficient to maintain bus service performance on surface streets in downtown Seattle, during the closure period and after the tunnel is re-opened at performance levels similar to those existing prior to the Closure Period. The Parties hereby establish a Monitor and Maintain Committee (M&M Committee) to be comprised of the designated contacts set forth in Section 20.0. The M&M Committee may be expanded to include participation by other public agencies at the discretion of the Parties. The M&M Committee shall conduct baseline studies of bus travel time and passenger convenience, security, safety and comfort during a measurement period prior to the Closure Period (Baseline Measurement Period.)”

“During the Closure Period and for one year after the Tunnel is reopened, the M&M Committee shall continue to monitor downtown Seattle transportation system performance and make recommendations to the Parties to take actions to maintain said system performance. In performing its functions, the Committee shall be directed to (a) consult with and seek input from suburban stakeholders and (b) report quarterly to the City Council’s Transportation Committee regarding the performance of the downtown transportation system and regarding the Committee’s consultation with various stakeholders.”

The M&M Committee issued its first performance report in September, 2005 just prior to tunnel closure. Volume 1 of the report documented pre-tunnel closure conditions for six specific performance measures. Data for this initial baseline report was collected during the spring and summer of 2005. The six performance measures are as follows:

- Measure 1: Transit travel time
- Measure 2: General purpose traffic operations
- Measure 3: Transit ridership and bus volumes
- Measure 4: Pedestrian activity at bus zones
- Measure 5: Seattle Central Business District (CBD) Customer Surveys
- Measure 6: Transportation Demand Management (TDM) mitigation programs

Volume 2 of the report was issued January, 2006. It provided the initial assessment of how the tunnel closure plan performed overall, and provided a detailed summary of the contingency planning effort that took place in the first 90 days following tunnel closure. The data sets used for Volume 2 were collected in the fall of 2005, following tunnel closure and extended up to the beginning of the Thanksgiving holidays. This allowed for a better comparison of before and after tunnel closure conditions in the Seattle central business district for non-holiday times.

Volume 3 of this report provides updates on a subset of the six performance measures. Specifically, Volume 3 provides updated information on Measures 1, 3 and 4. These measures are: transit travel time; transit ridership and bus volumes; and pedestrian activity at bus zones. For this report, transit travel time and bus volumes are derived from the first two weeks in February following the spring 2006 service change. Transit ridership figures were derived from the fall 2006 service change that ended on February 11, 2006. Pedestrian activity at bus stops was derived from a survey taken in late February/early March.

The projected schedule for the release of the balance of the report updates is identified in Figure 1, as are the updated data sets that will be available with each of these reports. There will be eight reports issued in total over the next three and one half years. With the release of Volume 3, there are five reports yet to be released.

Figure 1. Performance Report Release Dates

Performance Measure Updates	Performance Report Release Dates							
	Complete	Complete	Complete	July 06	Dec 06	June 07	Dec 07	Mar 08
	Sept 05	Jan 06	Mar 06					
	Volume 1	Volume 2	Volume 3					
Transit Travel Time	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
General Purpose Traffic Operations	⊙	⊙		⊙		⊙		⊙
Transit Ridership and Bus Volumes	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
Pedestrian Activity at Bus Zones	⊙	⊙	⊙				⊙	
Surveys of CBD customers	⊙			⊙				⊙
TDM mitigation programs	⊙	⊙		⊙	⊙	⊙	⊙	⊙

It is the intent of the M&M Committee to use these reports as a means of communicating on a regular basis the actions taken by the M&M Committee to address any deficiencies in the performance of the downtown core transportation system during tunnel closure. In July 2006 the M&M Committee will issue Volume 4, the fourth installment of this report.

Executive Summary

As previously reported, tunnel closure largely went as planned, and there were no major system failures. The problems and issues encountered in the first week following the September 2005 service change were fairly typical of any major transit service change. One factor contributing to the success of tunnel closure was the creation of an interagency Contingency Planning/Quick Response team, composed of representatives from Sound Transit, King County Metro, City of Seattle, Community Transit and Pierce Transit. This group actively monitored downtown traffic, transit operations and pedestrians following tunnel closure.

Following tunnel closure, one of the primary areas of focus for this Contingency Planning/Quick Response teams was the Stewart/Virginia transit corridor. This corridor experienced a significant increase in congestion and delay above what was expected. A set of additional improvements was identified and implemented to respond to these problems. However, all of the measures taken to address the problems in this corridor were not in place until February 2006. Therefore, Volume 3 of this report is the first opportunity to report on the combined effectiveness of the actions that were taken to address the problems on these two corridors.

Status of Stewart and Virginia Street Operations:

Following tunnel closure, PM peak travel times on Stewart Street increased to 10 minutes or more. On particularly congested evenings, the increased travel time could be in excess of 25 minutes. Virginia Street was also compromised but to a lesser extent. The conditions on Stewart and Virginia Streets were particularly problematic since they impacted a number of former tunnel routes, where the patrons were already experiencing a slower trip due to operation on surface streets. The operation on Stewart Street also impacted other areas in the Seattle Central Business District, including downstream bus stops that became more congested due to the service delays that caused waiting passengers to accumulate for longer periods of time.

The interagency Contingency Planning/Quick Response team immediately began to focus on developing solutions to these operations problems and a series of actions were taken by the City of Seattle and King County Metro following notification of affected properties. The City of Seattle implemented additional peak hour parking restrictions. They also installed pedestrian signal heads at Second Avenue and Stewart Street to better manage pedestrian/bus conflicts, and they relocated the charter bus zone for the Westin Hotel. Metro made a number of service adjustments, including relocating some routes off of Stewart Street, adjusting the stop pattern to reduce the number of times buses stopped on Stewart Street, closing the zone at Fifth Avenue and Westlake, and making numerous schedule adjustments to downtown core running times.

The cumulative effect of all these action has been quite positive. Stewart Street travel times have been reduced by seven minutes when compared with running time immediately after tunnel closure. The travel time on Stewart Street is now less than the time it took to travel this corridor before tunnel closure.

Although buses did not begin operation on Virginia Street until the September 2005 service change, travel time has also improved on Virginia Street by five to six minutes when comparing February 2006 data with September-November 2005 data. As importantly, the overall reliability for travel through both corridors has been improved substantially.

Other Performance Measures:

Additionally, Volume 3 of this Report provides updated information on the performance measures related to transit travel time, transit ridership and bus volumes, and pedestrian activity at bus stops in the Seattle Central Business District, post tunnel closure. Some key highlights from the updated information of these performance measures are noted below:

Transit Travel Time and Reliability

Travel time data for Volume 3 was collected from February 13 through February 24, 2006.

For the aggregate measure, the average travel time in downtown Seattle for operation on surface streets decreased by 22% over the baseline and by 33% compared with the initial tunnel closure results. This improvement is due in large part to the additional mitigation measures that were implemented on Stewart and Virginia Streets. It also reflects the schedule revisions that were made to capture the operating conditions on Third Avenue that were better than originally projected. It appears that the investments made to improve surface operations have helped improve surface travel times so much so, that even with the addition of the former tunnel buses, average travel times on surface streets are lower. Though it is still more expensive to operate the former tunnel routes on surface streets, worst case scenarios for surface operation during tunnel closure have been avoided.

It is probably prudent to caveat these findings with the following observations. The two weeks of February data measures a period of time with no unusual traffic conditions; there were no major holidays, sporting events or large public gatherings during this period in downtown Seattle. Updated traffic counts will not be available until Volume 4. Therefore, it is not known if there have been significant changes in traffic volumes on downtown streets and a corresponding reduction in congestion that might be assisting with the improved transit operations

At the corridor level, transit travel time comparisons were made using the two data sets collected since tunnel closure, the data from Volume 2, taken immediately after tunnel closure and the data set used for Volume 3 for February 2006. The results are summarized below:

- Travel time on northbound First Avenue improved by about two minutes between Volume 2 and Volume 3 in both the AM and PM peaks; in the northbound direction First Avenue now operates at level comparable to before tunnel closure. Southbound travel was essentially unchanged from Volume 2 results.
- Between Volumes 2 and 3, Second Avenue travel times were largely unchanged for the AM period but there was an improvement of about 1 minute in the PM period, making PM peak conditions comparable to before tunnel closure conditions.
- Third Avenue showed improvement in the northbound direction for the PM period; there were no substantial changes for the southbound direction or the AM period northbound; Third Avenue continues to perform better in the peak periods than before tunnel closure.
- Fourth Avenue showed improvement in both the AM and PM peak; in the PM peak, travel time was reduced by over 90 seconds on average.
- Travel on Virginia Street, Olive Way, and Howell all improved, in some cases by substantial amounts.
- Travel on Stewart Street improved by about seven minutes between Volume 2 and 3, and the current average travel times are now faster than the pre-closure baseline.

Transit Ridership and Bus Volumes

Based on fall 2004 data, ridership at the downtown screen line at University Street was 95,000 riders. This number increased to 106,700 riders in the spring 2005 service change (June through September) that immediately preceded tunnel closure. Based on complete data for the fall 2005 service change (September through November), ridership figures indicate that downtown loads crossing University Street have been reduced slightly, to 106,400.

Actual post tunnel closure bus volumes by street segment continue to be generally consistent with the bus volumes that were projected in the baseline report and subsequently reported in Volume 2.

Pedestrian Activity at Bus Zones

The majority of bus zones in the downtown core continue to function at acceptable levels for both waiting patrons and those passing through the zone. However, there were five zones previously identified in Volume 2 for additional monitoring or analysis. Based on updated surveys and analysis, all five of these bus stops now operate at acceptable levels of service for pedestrians traveling through the zone during the evening peak 15-minutes. In the full pedestrian waiting area, all of the bus stops are now operating at LOS A under HCM or “Desirable” under the King County system of measurement for waiting patrons.

Summary of Contingency Planning Measures for Stewart/Virginia Street



As the affected agencies prepared for the tunnel closure, an interagency “Quick Response Team” was established with representatives from King County Transit, Sound Transit, City of Seattle, Community Transit, and Pierce Transit. This team of individuals had the responsibility and authority from each of the involved agencies to quickly respond and correct problems as they occurred.

Following tunnel closure, staff from the Quick Response Team were physically assigned to locations throughout the downtown core, during the morning and evening peak periods, to watch, evaluate, and determine if any corrective actions

were needed to address operational or congestion related problems. Early in this monitoring process, it became apparent that Stewart Street between Second and Eighth Avenues was experiencing significant problems. Virginia Street was also being impacted, but to a lesser extent

Following tunnel closure, transit service on the Stewart Street and Virginia Street corridors experienced significant increases in congestion and delay. These conditions were documented in detail in Volume 2 of the *Post-Tunnel Closure Performance Report*. Transit travel times westbound on Stewart Street increased an average of 10 to 15 minutes per trip on many evenings as compared to pre-closure conditions. Delays of up to 25 minutes per trip were observed on some extremely congested evenings. Travel times eastbound on Virginia Street, although not as severe as Stewart Street, experienced average travel times increases of three to five minutes during the PM peak period. Schedules became very unpredictable and there were numerous customer complaints.

To mitigate these problems, the Quick Response Team was tasked with developing solutions that would help reduce the delay for transit and traffic along these two corridors. A concerted effort was made by the City of Seattle and the various transit agencies to expedite implementation of these changes to Stewart and Virginia Streets.

Since November of 2005, the City of Seattle has implemented the following changes:

- 31 additional parking stalls have been restricted during the PM peak on critical blocks along Stewart Street (mostly new restrictions, some changing from 4-6 to 3-7 p.m.)
- Pedestrian displays were installed at the intersection of Stewart Street and Second Avenue to control pedestrian crossing.
- The charter bus stop at the Westin Hotel was relocated, and the bus zone on Virginia Street, far side of Fifth Avenue, was extended.
- Traffic control at Stewart Street and Third Avenue was improved to help buses access Third Avenue more easily.

Since December of 2005, Metro KC has implemented the following changes:

- Six Metro routes were relocated from the Stewart Street Corridor.
- Stop patterns were consolidated for the remaining nine routes along Stewart Street.
- The bus zone at Westlake and Fifth Avenue was closed.
- The stop pattern was consolidated for the Route 7 local on Virginia Street.
- Schedule adjustments were made to improve on-time performance.

After implementation of the changes listed above, field observations were made and additional travel time measurements taken to assess the level of improvement. Both Transit operators and Metro Service

Quality staff have noted significant reductions in delay and corresponding improvement in travel time reliability along the corridors since the implementation of the improvements noted above.

Looking at transit travel time data from the downtown core monitoring system for the first two weeks of February, 2006, following the service change, there has been a significant improvement in the speed and reliability of transit service on both the Stewart Street and Virginia Street corridors. Transit travel times on Stewart and Virginia Streets are now shorter than before tunnel closure. This represents an 8 minute improvement on Stewart and a 5 minute improvement on Virginia.

Prompt, effective actions by the local agencies on the Quick Response Team resulted in significant improvement in the operation of the Stewart and Virginia Street corridors. Hundreds of daily transit riders from three different counties in the region benefit from the improved conditions on these two corridors. General purpose traffic has been served, as well. Other factors that may also have contributed to improved operations are as follows:

- Transit operators from each agency have become more familiar with how to drive these corridors efficiently.
- General purpose traffic has also become more adept at navigating downtown during the peak periods.
- Following the Christmas/New Year period, holiday and major event traffic have not been a significant factor.

Measure 1: Transit Travel Time

Monitoring Objectives

The purpose of monitoring transit travel times is to answer the following questions regarding transit travel times in the Seattle downtown core before and after tunnel closure:

- How long are the transit travel times in the Seattle downtown core?
- How consistent are the transit travel times in the Seattle downtown core?
- Where are slowdowns occurring and are there mitigation measures that might address these slowdowns?

Methodology

Transit travel times on surface streets were measured using roadside bus detection equipment at 16 locations in the Seattle downtown core. The locations of these detection points are identified in Figure 2. A description of the equipment and technology can be found in the Methodology section of the baseline tunnel closure report.

The collection of transit travel times began in summer 2005 and will be continuously collected throughout the tunnel closure period. Two levels of data are included in the regular performance reports issued by the Monitor and Maintain Committee:

Level 1: Seattle downtown core summary statistics will be the highest level summary. They consist of aggregated travel times through the study area to define an average transit operating time in the Seattle downtown core on surface streets for the AM peak and the PM peak. This measure will show the amount of time a bus takes on average to traverse the downtown area. Considered over time, this measure will give an overall trend of the increase or decrease in delay on surface streets caused by tunnel closure.

Level 2: Transit Corridor Travel Time summary will track travel time along a discrete set of transit corridors on surface streets in the central business district. The transit corridors included in the monitoring are identified in Figure 2. The data will be categorized by corridor and by time of day (AM Peak and PM Peak). Variability of the data will also be reported to show the consistency of transit travel times.

Figure 2. Transit Travel Time Summary Analysis Corridors and Detection Point Locations



Transit Travel Time Comparison

Data for transit travel time in the Seattle downtown core post tunnel closure is collected continuously. For this report, weekday travel times between February 13, 2006 and February 24, 2006 were used. This period was used to coincide with the spring 2006 service change that went into effect Saturday, February 11. Time of day periods, monitoring locations and analysis tiers, as described in the previous section, are the same as the baseline report except where noted.

In general, transit travel time averages on surface streets for this period were faster than the initial post-closure period results. On Third Avenue, conditions for transit improved slightly, maintaining the noticeable improvement over the pre-closure baseline. East-West conditions on Stewart Street and Virginia Street were notably improved over the initial post-closure results. Unsatisfactory performance was identified soon after tunnel closure and additional mitigation actions were taken. The additional mitigation had a significant, positive impact on these two corridors.

Seattle downtown core Travel Time Summary (Level 1):

The first level of analysis for downtown transit travel time is a composite measurement of average time spent in the study area. This value is obtained by identifying the first and last observation of a bus trip in the downtown core, regardless of the corridor. Averaging this figure for all trips results in a single value of time spent in the downtown core for all observed trips.

This value is used as an index, not a measure. This figure includes layover time as well as through-routed trips under one measurement. It will also include many different paths through the downtown core with different lengths and travel conditions. The measure becomes meaningful when compared to the same measurement in the future to compare the ease of travel for transit through the downtown core.

The data used for this reporting period includes only the first two weeks in February, 2006 immediately following the February service change. This is the first data set that was available to evaluate all of the post tunnel closure adjustments that are the primary reason for this report.

The baseline Travel Time Index is **100**, representing the value before tunnel closure. The average travel time value was determined to be 21:59, based on bus trips between 4 - 6 p.m. on weekdays during the month of July. The Travel Time index for this reporting period is **78**. This represents a **22%** decrease in time spent in the downtown core over the baseline, and a 33% decrease over the previous index measured in November 2005. The dramatic improvement is due to the implementation of additional mitigation measures on Stewart and Virginia Streets, as well further adjustments to bus schedules to reflect improved downtown core operating conditions, particularly along Third Avenue.

There may also be other factors contributing to the improvement in the Travel Time Index. First, the February data that was used does not include the impacts of seasonal holidays. There were no major sporting events or other major public events in downtown Seattle in this two week period that would negatively impact this index. There is also no updated information available on traffic volumes so it is not possible to determine if overall congestion levels in downtown Seattle have been reduced due to lower traffic volumes. Finally there may be some inherent seasonal variations impacting the comparison of baseline travel time value that was derived from data collected in the July 2005 with the travel time value reported for February 2006 in Volume 3. With the next report, Volume 4, it will be possible to see if the current level of street operation can be maintained based on a more complete data set, which will also capture the traffic impacts of a number of sporting events in this time period.

Transit Corridor Travel Time Summaries (Level 2)

The four charts in Figure 3 show the average travel times for transit after tunnel closure. The data was collected in February 2006 using the monitoring system. The data used is from weekdays only. Each chart shows the average travel time for the direction of travel and time of day indicated. The AM charts include buses observed between 7 – 9 a.m. at the first reader on the corridor being measured. The PM charts cover the time period from 4 – 6 p.m.

The average corridor travel times in this report are compared to the comparable statistics for both pre-tunnel closure baseline conditions and for the first post tunnel closure data reported in Volume 2. Corridor travel times should not be compared to each other. Readers were placed to ensure route coverage. Readers were also sited to facilitate communications and insure access to power. As a result, the measured corridors differ in length, number of stops and number of signals, all of which affect travel time but are not related to congestion.

The reader locations that define the boundaries of each of the transit corridors are described below along with a table for each corridor that summarizes the Average Travel Time by time period along with the standard deviation (SD) of the observations in minutes. As a statistical measure, approximately 69% of all observations are within one standard deviation of the average. The SD can be interpreted as approximating the range (+/- SD) of the typical travel time that a majority of bus riders will experience on the corridor. There are currently three data points; pre-tunnel baseline; Volume 2 date post-tunnel closure observations; and Volume 3 post tunnel closure observations.

Figure 3. Transit Corridor Travel Time after Tunnel Closure, February 2006

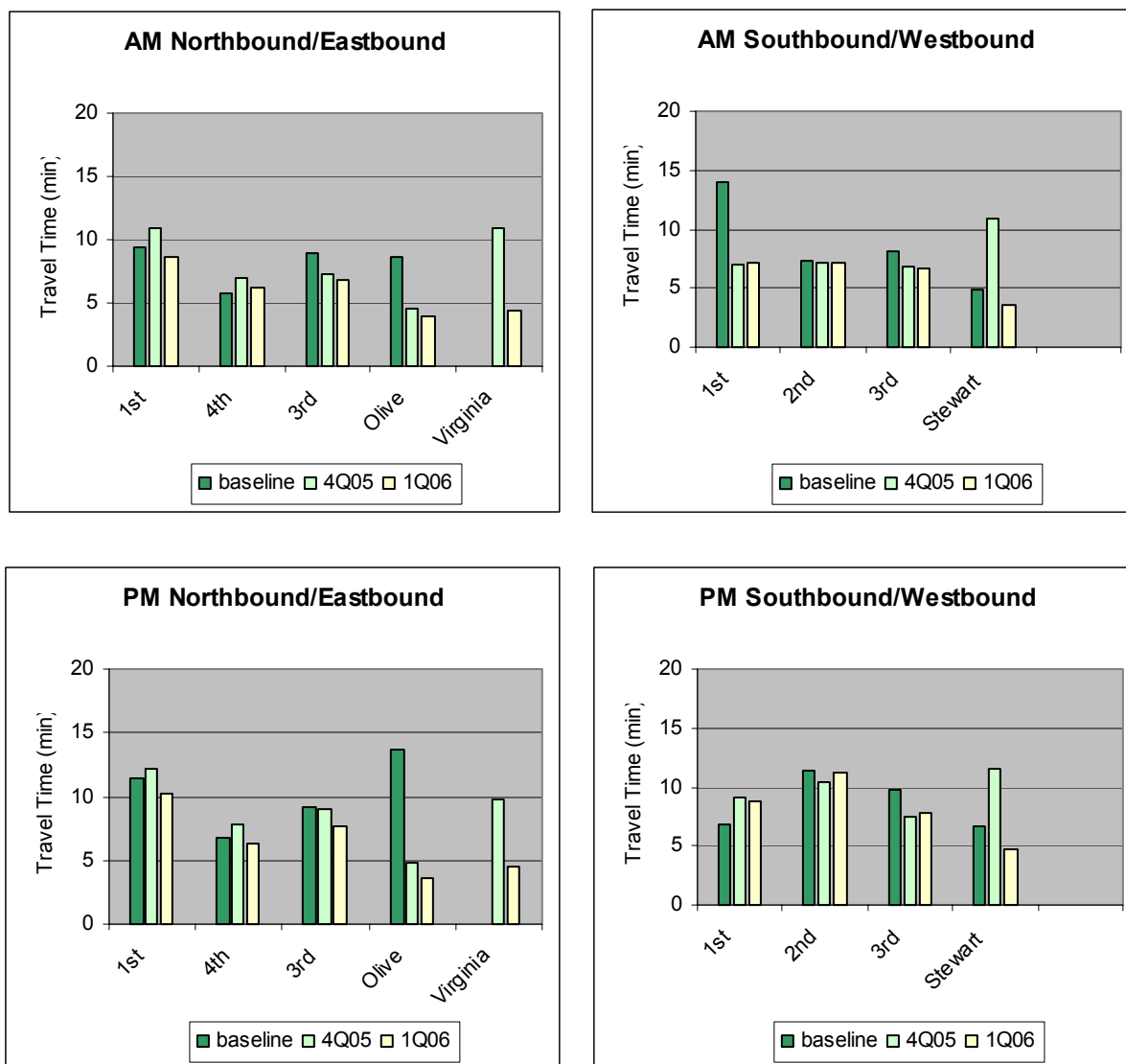


Figure 4A. First Avenue Transit Travel Time and Variation

First Avenue	AM Peak (7 – 9 a.m.)	PM Peak (4 – 6 p.m.)
Northbound, Royal Brougham to Seneca Street	Travel time: Baseline – 9 min 22 sec (<i>SD: 4.8 min</i>) Volume 2 – 10 min 54 sec (<i>SD: 5.8 min</i>) Volume 3 – 8 min 36 sec (<i>SD: 1.8 min</i>) Change : -2min 18sec	Travel Time: Baseline – 11 min 24 sec (<i>SD: 5.3 min</i>) Volume 2 – 12 min 12 sec (<i>SD: 6.0 min</i>) Volume 3 – 10 min 18 sec (<i>SD: 3 min</i>) Change : -1min 54sec
Southbound, Seneca Street to Royal Brougham*	Travel time: Baseline – 14 min (<i>SD: 8.8 min</i>) Volume 2 – 7 min (<i>SD: 5.4 min</i>) Volume 3 – 7 min 8 sec (<i>SD: 1 min</i>) Change : +8sec	Travel time: Baseline – 6 min 51 sec (<i>SD: 3.9 min</i>) Volume 2 – 9 min 6 sec (<i>SD: 6 min</i>) Volume 3 – 8 min 49 sec (<i>SD: 1.4 min</i>) Change : -17sec

First Avenue (Northbound and Southbound) reader locations are Royal Brougham to the south and Stewart Street to the north, with a midpoint at Seneca Street. However, the baseline travel time measurements were taken for the segment between Seneca Street and Royal Brougham because the Stewart reader was not available for the initial survey. For consistency, future data measures will use the same start and end points as the baseline report.

Figure 4B. Second Avenue Transit Travel Time and Variation

Second Avenue	AM Peak (7 – 9 a.m.)	PM Peak (4 – 6 p.m.)
Southbound, Pike Street to S Jackson Street	Travel time: Baseline – 7 min 20 sec (<i>SD: 1.9 min</i>) Volume 2 – 7 min 13 sec (<i>SD: 2.6 min</i>) Volume 3 – 7 min 11 sec (<i>SD: 1.45 min</i>) Change : - 2sec	Travel time: Baseline – 11 min 26 sec (<i>SD: 4.3 min</i>) Volume 2 – 10 min 26 sec (<i>SD: 3.5 min</i>) Volume 3 – 11 min 10 sec (<i>SD: 2.4 min</i>) Change : +44sec

Second Avenue (Southbound only) reader locations are Pike Street and S Jackson Street with a midpoint at Seneca Street. Second Avenue maintained the same average travel time with slightly less variation in the AM Peak. In the PM Peak, average travel times degraded by 44 seconds, but remained better than the baseline and improved an additional one minute in and variation. Over three study periods, the variation in average travel time is less than the standard deviations suggesting the conditions on Second Avenue have been consistent.

Figure 4C. Third Avenue Transit Travel Time and Variation

Third Avenue	AM Peak (7 – 9 a.m.)	PM Peak (4 – 6 p.m.)
Northbound, Yesler Way to Stewart Street	Travel time: Baseline – 9 min (<i>SD: 4.6 min</i>) Volume 2 – 7 min 20 sec (<i>SD: 3.1 min</i>) Volume 3 – 6 min 53 sec (<i>SD: 1.3 min</i>) Change : -27 sec	Travel Time: Baseline – 9 min 6 sec (<i>SD: n/a</i>) Volume 2 – 8 min 57 sec (<i>SD: 3.6 min</i>) Volume 3 – 7 min 41 sec (<i>SD: 1.3 min</i>) Change : -1min 16sec
Southbound, Stewart Street to Yesler Way	Travel time: Baseline – 8 min 5 sec (<i>SD: 1.3 min</i>) Volume 2 – 6 min 52 sec (<i>SD: 2.8 min</i>) Volume 3 – 6 min 36 sec (<i>SD: 1.6 min</i>) Change : -16sec	Travel time: Baseline – 9 min 45 sec (<i>SD: 2.5 min</i>) Volume 2 – 7 min 27 sec (<i>SD: 2.9 min</i>) Volume 3 – 7 min 51 sec (<i>SD: 1.5 min</i>) Change : +24sec

Third Avenue (Northbound and Southbound) reader locations are Stewart Street to the north and Yesler Way to the south, with a midpoint at Seneca Street. Average travel times improved in both directions and in both peak periods compared to before tunnel closure due to traffic restrictions and transit lanes implemented on the corridor. Average travel times were improved over the previous reporting period in all cases except the PM Peak southbound. In all cases the standard deviation was reduced indicating more consistent travel times.

In the previous reporting period, traffic restrictions were removed after 6:30 p.m. with no negative effect noted. The increase in average travel time in the southbound PM Peak is not due to this change. Travel times in the southbound direction on Third Avenue between 6:30 and 7 p.m. averaged seven minutes, 31

seconds. The changes in average travel times the southbound direction in both the AM and PM periods are less than the standard deviation suggesting conditions in the southbound direction have been consistent. Northbound reduction in average travel times are more significant, and probably related to improvements on Virginia Street.

Figure 4D. Fourth Avenue Transit Travel Time and Variation

Fourth Avenue	AM Peak (7 – 9a.m.)	PM Peak (4 – 6 p.m.)
Northbound, S Jackson Street to Seneca Street	Travel time: Baseline – 5 min 48 sec (<i>SD: 1.2 min</i>) Volume 2 – 6 min 58 sec (<i>SD: 2.8 min</i>) Volume 3 – 6 min 14 sec (<i>SD: 1.35 min</i>) Change : -44 sec	Travel Time: Baseline – 6 min 46 sec (<i>SD: 1.1 min</i>) Volume 2 – 7 min 50 sec (<i>SD: 4 min</i>) Volume 3 – 6 min 15 sec (<i>SD: 2 min</i>) Change : -1min 35sec

Fourth Avenue (Northbound only) reader locations are Seneca Street to the north and S Jackson Street to the south. Average travel times decreased by one minute during both the morning and evening peak periods, with notably less variation. Average travel times are near or below the pre-closure baseline with similar variation. The increased travel times in the previous period appear to have been related to a group of trips experiencing longer travel times while other trips maintained pre-closure travel times. In this period, there was more consistency in travel times.

Figure 4E. Virginia, Olive Way and Howell Transit Travel Time and Variation

	AM Peak (7 – 9a.m.)	PM Peak (4 – 6 p.m.)
Eastbound Virginia, Third Avenue to Ninth Ave	Travel time: Volume 2 – 10 min 39 sec (<i>SD: 5.1 min</i>) Volume 3 – 4 min 23 sec (<i>SD : .9 min</i>) Change : -6min 16sec	Travel Time: Volume 2 – 9 min 50 sec (<i>SD: 4.9 min</i>) Volume 3 – 4 min 28 sec (<i>SD: 1 min</i>) Change : -5min 22sec
Eastbound Olive Way, Third Avenue to Eighth Ave	Travel time: Baseline – 8 min 42 sec (<i>SD: 9.1 min</i>) Volume 2 – 4 min 34 sec (<i>SD: 2.4 min</i>) Volume 3 – 3 min 54 sec (<i>SD : 1 min</i>) Change : - 40sec	Travel Time: Baseline – 13 min 43 sec (<i>SD: 9.7 min</i>) Volume 2 – 4 min 51 sec (<i>SD: 2.5 min</i>) Volume 3 – 3 min 41 sec (<i>SD : .9 min</i>) Change : -1min 10sec
Eastbound Howell, Eighth Ave to Yale Street	Travel time: Baseline – 2 min 6 sec (<i>SD: 1.4 min</i>) Volume 2 – 3 min 53 sec (<i>SD: 2.4 min</i>) Volume 3 – 3 min 23 sec (<i>SD : 1.6 min</i>) Change : -30sec	Travel Time: Baseline – 5 min 25 sec (<i>SD: 3.1 min</i>) Volume 2 – 5 min 37 sec (<i>SD: 3.3 min</i>) Volume 3 – 4 min 50 sec (<i>SD: 2.3 min</i>) Change : -47sec

Virginia Street (Eastbound only) reader locations are Third Avenue at Stewart to the west and Ninth Avenue at Stewart to the east. Virginia Street was not a transit routing before the tunnel closure, so there is no baseline data. Average travel times were reduced by over five minutes with the implementation of additional mitigation measures.

Olive Way (Eastbound only) reader locations are Third Avenue to the west and Eighth Avenue to the east. Average travel times improved to less than four minutes on Olive Way between Third and Eighth Avenues. Travel time variation improved as well.

Howell (Eastbound only): Transit on Howell east of Eighth Avenue improved slightly, with variation decreasing by about one minute in both the AM and PM peak periods.

Figure 4F. Stewart Street Transit Travel Time and Variation

	AM Peak (7 – 9a.m.)	PM Peak (4 – 6 p.m.)
Westbound, Ninth Avenue to Third Avenue	Travel time: Baseline – 4 min 50 sec (<i>SD: 1.9 min</i>) Volume 2 – 10 min 52 sec (<i>SD: 5.2 min</i>) Volume 3 – 3 min 31 sec (<i>SD: 1 min</i>) Change : -7min 21 sec	Travel Time: Baseline – 6 min 42 sec (<i>SD: 1.5 min</i>) Volume 2 – 11 min 36 sec (<i>SD: 4.9 min</i>) Volume 3 – 4 min 42 sec (<i>SD: 2 min</i>) Change : -6min 54 sec

Stewart Street (Westbound only) reader locations are Third Avenue to the west and Ninth Avenue to the east. Average travel time on Stewart Street decreased by more than seven minutes with the implementation of additional mitigation measures. The current average travel times are now one to two minutes faster than the pre-closure baseline. Variation also decreased dramatically.

Measure 3: Transit Ridership and Bus Volumes

Monitoring Objectives

The purpose of monitoring transit passenger and bus volumes is as follows:

- Provide data on bus volumes by street segment in downtown Seattle
- Measure the average weekday PM peak hour and weekday passenger loads crossing the Seattle downtown core north-south screen line
- Provide data as available from Community Transit and Pierce Transit on average ridership crossing the north-south screen line during average PM peak hours and weekdays
- Identify and analyze any substantive changes in ridership or bus volumes for before and after tunnel closure conditions

Methodology

Bus volumes used for this analysis were extracted from HASTUS - the King County Metro scheduling system - using the February 2006 service change. These counts include in service as well as out of service coaches. A projection of bus volumes on downtown streets for after tunnel closure was issued with Volume 1, the Baseline Report. These projected bus volumes will be compared with bus volumes from the February 2006 service change.

For passenger loads, the Automated Passenger Count (APC) system is the primary source for passenger data for Metro coaches. APC data is collected in a random sample during each signup, downloaded and processed monthly. This data is summarized in a final form at the end of each signup. Preliminary data, based on smaller samples, is available monthly. Metro driver count data is collected on an ad hoc basis when preliminary APC results indicate that observations of trips on a particular route will fall below an adequate sample. Ridership data on Community Transit and Pierce Transit service is generated by the monitor reports supplied by each of these agencies. The ridership data from Community Transit and Pierce Transit is available by signup at the aggregate level.

APC data, supplemented by driver counts and estimates for any non-APC-observed trips, was used to estimate Metro ridership volumes crossing the screen line just south of University Street, by trip, for the spring 2005 and fall 2005 signups during the PM Peak hour and the average weekday. The results have been summarized by street and by direction to compare ridership volumes and loads before and after tunnel closure.

Bus Volumes

The bus volumes that were projected for downtown street segments during tunnel closure, as shown in the Volume 1 Baseline report, are summarized in Figure 5A. The actual post tunnel bus volumes for downtown streets, as of the February 2006 service change are shown in Figure 5B. Overall, bus volumes on most street segment in the downtown core during the PM Peak continue to be comparable to what was projected

The PM Peak period used for determining transit volumes is 4:30 to 5:30 p.m. Slight variations in volumes are due to schedule adjustments that change a trip from being included or excluded within the measured peak hour. Other changes in bus volumes can be attributed to the relocation of approximately four trips from Second Avenue to Third Avenue, and the service adjustments related to Stewart Street.

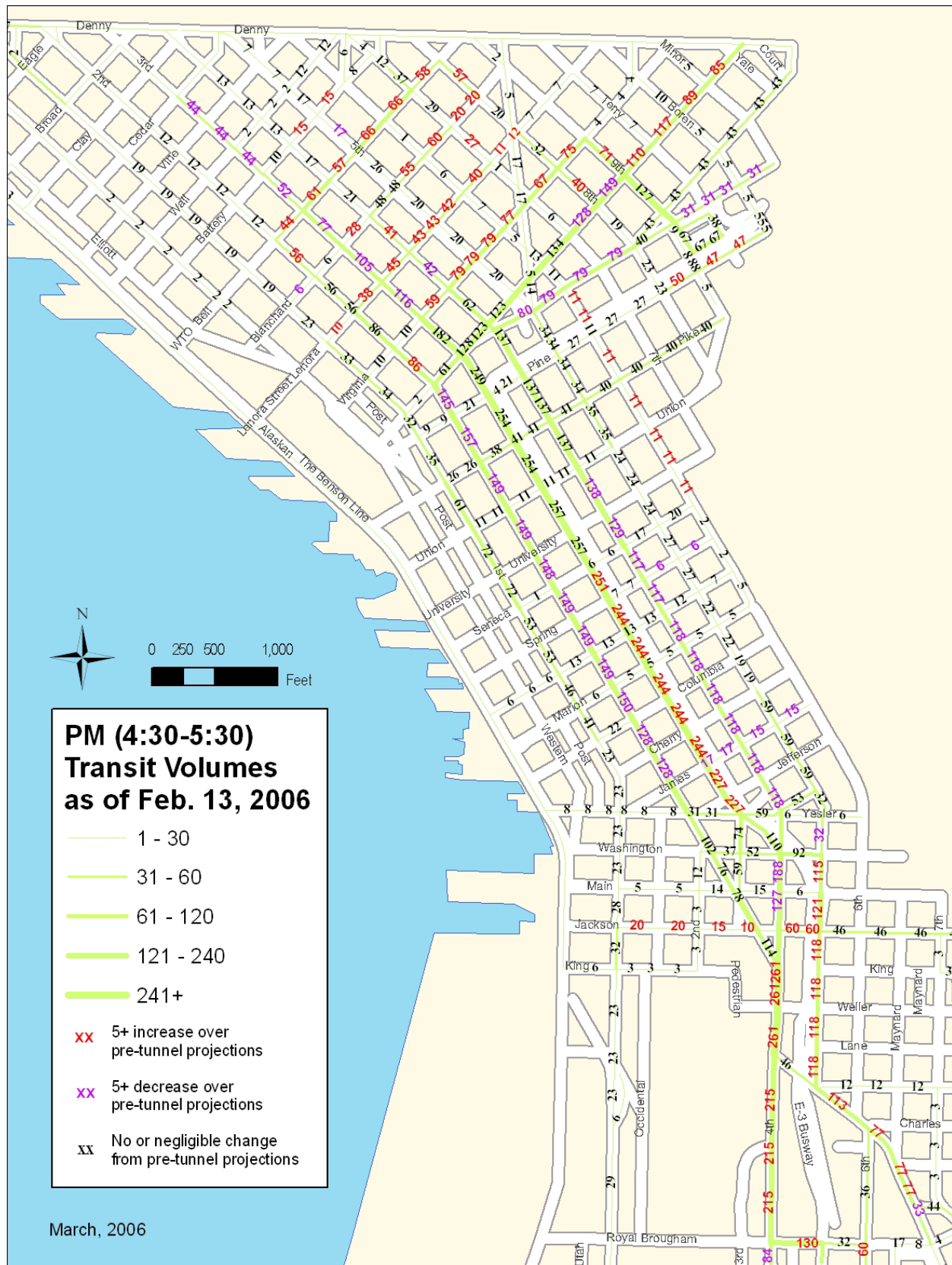
Projected PM (4:30-5:30) Transit Volumes

August, 2005

Legend:

- 1 - 30
- 31 - 60
- 61 - 120
- 121 - 240
- 241+

Figure 5B. PM Peak Hour Transit Volumes as of February, 2006 Service Change (includes Stewart Adjustments)



Transit Ridership Volumes

Prior to tunnel closure, approximately 95,000 north-south riders crossed the downtown screen line on King County Metro-operated service at University Street on weekdays in the fall signup of 2004. As part of a general increase in ridership, this number increased to almost 106,700 weekday riders in the spring signup of 2005. In the fall 2005 signup, ridership figures indicated that downtown loads crossing University Street had fallen slightly, to about 106,400. In addition, overall ridership on Community Transit-operated commuter services from downtown Seattle to Snohomish County increased by about 8.1 percent between May and October 2005. Ridership on Sound Transit commuter services from Pierce County as operated by Pierce Transit decreased by 4.7 percent but for the same period ridership on Sounder grew by 39.8 percent, for a net increase.

Given the general upward trend in system ridership, this report uses spring 2005 data for the before tunnel closure condition rather than fall 2004 to reflect the ridership growth that occurred prior to tunnel closure. Because Community Transit and Pierce Transit do not keep segment-level load statistics, the following discussion uses King County Metro data only.

In Volume 2 of this report, the ridership comparison was based on preliminary data from the fall 2005 service change. With this update, the final ridership statistics for fall 2005 are now available. Figure 6 compares the fall 2005 ridership at University Street on King County Metro-operated service with the baseline spring 2005 loads. Average weekday loads decreased by about one-fourth of one percent. However, the total load crossing the screenline during the peak hour from 4:30 to 5:30 p.m. actually increased by about 4.5 percent, with much of that increase occurring late in the signup, possibly indicating increasing passenger confidence in transit reliability during the peak of the peak.

Figure 6. Passenger Loads at University Street, before and after Tunnel Closure

		Weekday Riders		Percent Change	1-Hr PM Peak Riders		Percent Change
Avenue	Dir	Spring 2005	Fall 2005		Spring 2005	Fall 2005	
First	N	9,861	10,077	+2.2%	757	788	+4.1%
	S	6,002	6,475	+7.9%	769	756	-1.7%
Second	S	16,423	15,808	-3.7%	2,465	2,566	+4.1%
Third	N	17,849	28,267	+58.4%	1,478	3,157	+113.6%
	S	17,239	26,118	+51.5%	1,883	3,281	+74.2%
Fourth	N	10,375	15,301	+47.5%	825	1,213	+47.0%
Fifth	S	3,046	4,441	+45.8%	155	238	+53.5%
Tunnel	N	12,991	N.A.		1,188	N.A.	
	S	14,495	N.A.		1,959	N.A.	
Total		106,651	106,387	-0.2%	11,479	11,998	+4.5%

Figure 7 uses fall 2005 data to compare standing loads at University Street with the baseline spring 2005 standing loads. While the incidence of standing loads has increased, as expected, it is well below the level of concern.

Figure 7. Loads over Seating Capacity at University Street, before and after Tunnel Closure

		Average Loads Greater than Seat Capacity				Average Loads 20% over Seating Capacity			
		% of Weekday Trips		% of Peak 1-Hr Trips		% of Weekday Trips		% of Peak 1-Hr Trips	
Avenue	Dir	Spring 05	Fall 05	Spring 05	Fall 05	Spring 05	Fall 05	Spring 05	Fall 05
First	N	1.8%	2.0%	7.5%	8.8%	0.0%	0.2%	0.0%	0.0%
	S	1.3%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Second	S	0.3%	0.5%	0.0%	0.9%	0.0%	0.5%	0.0%	0.9%
Third	N	1.2%	1.7%	1.5%	0.0%	0.2%	0.2%	0.0%	0.0%
	S	5.0%	3.5%	4.7%	3.8%	1.3%	0.8%	1.6%	0.0%
Fourth	N	0.5%	0.5%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%
Fifth	S	0.8%	0.0%	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%
Tunnel	N	0.4%	N.A.	0.0%	N.A.	0.0%	N.A.	0.0%	N.A.
	S	0.2%	N.A.	0.0%	N.A.	0.0%	N.A.	0.0%	N.A.
Total		1.3%	1.5%	1.4%	1.6%	0.3%	0.3%	0.2%	0.2%

Fall 2005 data indicates that loads leaving the downtown core have declined about one percent from those in spring 2005, from about 90,800 riders to about 89,600 riders each weekday. However, standing loads have increased, although, again, they are still a small fraction of outbound trips. Figure 8 compares the percent of trips with standing loads leaving downtown at various times of the day. The largest increase, not surprisingly, is in the PM peak, when 4.2% of trips leaving the Seattle downtown core had standing loads, as compared to 3.4% of trips in spring 2005. This increase was spread across a number of routes, including ones not likely to be directly affected by tunnel closure.

Figure 8. Percent of Trips Leaving CBD Averaging Standing Loads, before and after Tunnel Closure.

		AM Peak	Midday	PM Peak	Evening	Total
		6-9 AM	9AM–3 PM	3-7 PM	7-11 PM	
Standing Loads	Spring 2005	2.4%	2.7%	3.4%	0.3%	2.4%
	Fall 2005	2.8%	3.0%	4.2%	0.8%	3.2%
Over 120% Load	Spring 2005	0.0%	0.7%	0.5%	0.0%	0.4%
	Fall 2005	0.6%	0.8%	0.8%	0.0%	0.7%

Measure 4: Pedestrian Activity at Bus Zones

Monitoring Objectives

The purpose of monitoring pedestrian activity at bus zones is to quantitatively assess pedestrian congestion at critical bus stops within the Seattle downtown core. In particular, the study focused on the impacts that transit tunnel closure had on pedestrian congestion at or near bus stops on surface streets. This portion of the study aims to answer the following key questions:

- How crowded are bus stops five months after tunnel closure?
- Have the mitigation measures taken to address pedestrian congestion proved to be effective?
- Are there ongoing pedestrian congestion issues that warrant further study or mitigation?

Methodology

The studies for pedestrian activity at bus zones have focused on two elements of pedestrian congestion: pedestrian crowding and pedestrian flow.

Pedestrian crowding is applicable to waiting and queuing areas, and is based on the average space available per person. The *Transit Cooperative Research Program (TCRP) Transit Capacity and Quality of Service Manual* specifies criteria for Level of Service (LOS) designations ranging from A to F for queuing and waiting areas (Part 7, Chapter 3). In addition to these national guidelines, Metro applied its own criteria to the amount of space available per person in bus stop waiting areas.

Pedestrian flow is applicable to the movement through the bus zone and is based on the number of pedestrians passing per minute passing through a walkway of limited width. The *2000 Highway Capacity Manual* specifies criteria for LOS designations of A through F for walkways. In addition to these criteria, pedestrian level of service will be further evaluated using procedures outlined in *Urban Spaces for Pedestrians* by Pushkarev and Zupan (1975),

Refer to Volume 1 of the *Performance Report on Surface Streets in the Seattle Central Business District* for a more detailed description of the pedestrian survey methodology and criteria used for pedestrian level of service assessment.

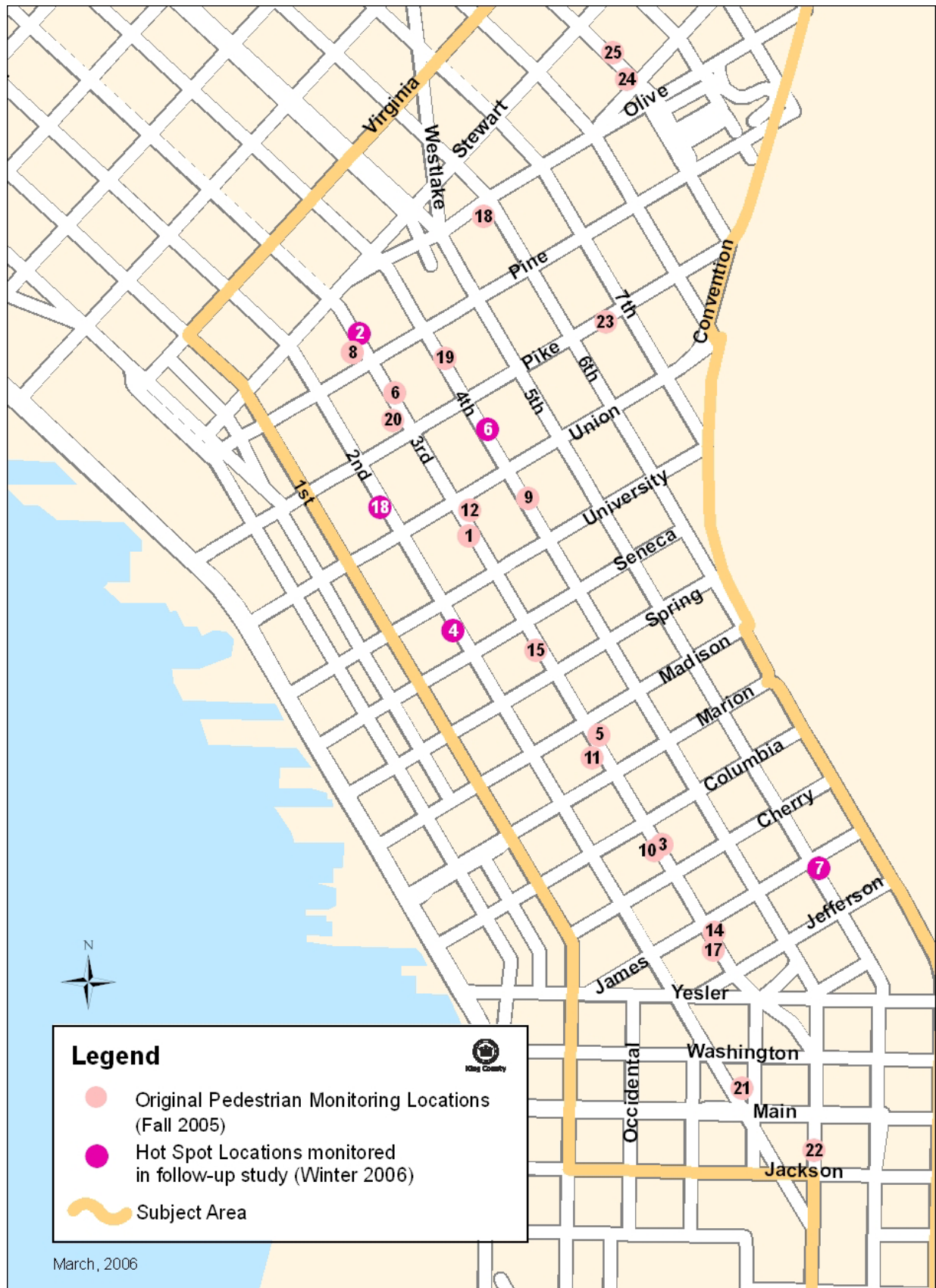
To measure the pre-tunnel closure conditions, an initial pedestrian congestion study was conducted at 19 selected bus zones in spring, 2005¹. These results were reported in Volume 1. In the first after-tunnel closure study, conducted in fall, 2005, 25 bus zones were studied, including newly installed bus stops². These results were reported in Volume 2. Based on these results, five of these locations were selected for further study, to be reported in Volume 3. These five zones were monitored to see if the level of service could be improved. The data presented in this third volume are the results of this follow-up study. The results from this follow study were compared with the fall, 2005 conditions, following tunnel closure. Figure 9 shows the 25 bus stops that were surveyed in the fall, 2005; the 5 zones that were identified for additional evaluation are highlighted.

All of the data collection for the follow-up study was conducted on Tuesday, February 28 and Thursday, March 2. Additional pedestrian counts may be collected to measure conditions after the tunnel is re-opened.

¹ Pedestrian Congestion Study, Existing Conditions Analysis. 7-18-2005

² Pedestrian Congestion Study, Fall 2005 Conditions Report, 11-23-2005

Figure 9. Bus Stops Surveyed for Pedestrian Congestion Counts



Follow-up Studies for Selected Zones

Figure 10 summarizes the results of the follow-up studies at the five zone selected for further monitoring, as they relate to pedestrians walking through the bus zones. Figure 11 summarizes the results of the after-closure and follow-up studies as they relate to pedestrians waiting at the bus stops. In the next subsection, the various factors affecting changes in the conditions are discussed in more detail.

Figure 10. Walking Pedestrian Rank and Level of Service by Bus Stop (*Map ID# corresponds to locations shown on Figure 9*)

Location				Fall 2005 (after closure)		February 2006 (follow-up study)	
Map ID #	Bus Stop #	Dir	On-street/Cross-street	Pushkarev & Zupan Rank	HCM LOS	Pushkarev & Zupan Rank	HCM LOS
2	590	NB	3rd Ave./Pine St.	Impeded	A	Impeded	A
4	315	SB	2nd Ave./University St.	Impeded	A	Impeded	A
6	690	NB	4th Ave./Union St.	Constrained	C	Impeded	A
7	860	NB	5th Ave./James St.	Impeded	A	Impeded	A
18	300	SB	2nd Ave./Pike St.	Impeded	A	Unimpeded	A

All five of these bus stops now operate at acceptable levels of service during the evening peak 15 minutes. Two of the bus stop locations have shown some improvement in levels of service since the fall 2005 study.

Figure 11. Standing Pedestrian Level of Service for Full Bus Stop Area and Critical Loading Zone (*Map ID# corresponds to locations shown on Figure 9*)

Location			Fall 2005 (after closure)				February 2006 (follow-up study)			
			Full Zone		Critical Zone		Full Zone		Critical Zone	
Map ID #	Bus Stop #	On-street/Cross Street	HCM LOS	King County Rank	HCM LOS	King County Rank	HCM LOS	King County Rank	HCM LOS	King County Rank
2	590	3rd Ave./Pine St.	A	Constrained	A	Constrained	A	Desirable	A	Constrained
4	315	2nd Ave./University St.	A	Desirable	B	Constrained	A	Desirable	A	Desirable
6	690	4th Ave./Union St.	A	Desirable	A	Desirable	A	Desirable	A	Desirable
7	860	5th Ave./James St.	B	Constrained	C	Uncomfortable	A	Desirable	A	Constrained
18	300	2nd Ave./Pike St.	A	Desirable	B	Constrained	A	Desirable	B	Constrained

In the full pedestrian waiting area, all of the bus stops are now operating at LOS A under HCM or “Desirable” under the King County system of measurement. In the critical loading area, all bus stops are operating with LOS B and “Constrained” conditions or better, with two of the stops showing some improvement since the fall, 2005 study.

Summary Observations

Generally, the maximum number of pedestrians observed waiting at bus stops in the downtown core has been reduced since the initial tunnel closure period. As transit customers have become more familiar with the new surface street routings and as schedule reliability has improved, customers are experiencing shorter wait times at these bus stops, thereby reducing the maximum numbers of patrons waiting for a bus.

For the five locations for which additional monitoring was performed, an updated status report for each is provided below:

- **Zone 590 (NB Third Ave & Pine St):** During the fall 2005 study, constrained waiting conditions were recorded for the full bus zone area. The follow-up study expanded the pedestrian waiting area to include some of the area adjacent to the Macy's store loading dock, at the north end of the bus zone, because transit passengers were observed waiting in this area in the few weeks after tunnel closure. However, when the follow up study was conducted, the number of waiting passengers was found to be lower, and few people were observed waiting in the loading dock area. This bus stop now operates with desirable waiting conditions for the full bus zone.
- **Zone 315 (SB Second Ave & University St):** Levels of service for waiting pedestrians within the critical loading zone have improved at this location. This could be attributable to the removal of the bus shelter side panels, which has improved pedestrian circulation within the zone and has encouraged people to utilize the full bus zone while waiting for their bus to arrive.
- **Zone 690 (NB Fourth Ave & Union St):** A pedestrian count was not conducted at this location as part of the follow-up study, however the level of service was re-calculated to reflect the removal of the temporary construction fencing that had been constraining though pedestrian movement. The level of service for through pedestrians is now adequate.
- **Zone 860 (NB Fifth Ave & James St):** This bus stop has shown a significant improvement in pedestrian waiting level of service, compared to the constrained waiting conditions and uncomfortable crowding in the critical loading zone that were observed just after tunnel closure. These early conditions were partly attributable to the fact that many transit routes that serve this bus zone originate in the north downtown core area, and these buses were caught in delays on Stewart Street. Since reliability has improved for these routes, the number of people observed waiting at this stop has been reduced by almost 50%.
- **Zone 300 (SB Second Ave & Pike St):** This bus stop continues to experience constrained conditions within the critical loading zone, while the total bus zone waiting area operates with desirable conditions. To help mitigate this condition, the rear panels of the bus shelters could be removed to improve pedestrian circulation; however this measure would also reduce quality of shelter available to waiting transit customers during periods of inclement weather. At this time, no further action is planned.

With the completion of this follow up study, no additional pedestrian counts are presently planned for the balance of the tunnel closure period. This can change if new bus stop related problems are identified. It is anticipated that some additional counts will be taken to measure conditions at bus stops when the tunnel re-opens.